

HEART MURMURS

PART I

BY

WILLIAM EVANS

From the Cardiac Department of the London Hospital

Received November 5, 1946

Auscultation of the heart, depending as it does on the acuity of the auditory sense and providing information commensurate with the observer's experience, cannot always determine unequivocally the various sound effects that may take place during systole and diastole. It is not surprising, therefore, that auscultation tied to traditional theories may sometimes lead to a wrong interpretation of the condition, although a judgment born of ripe experience in clinical medicine and pathology will avoid serious mistakes. It is more than fortuitous that modern auscultation has grown on such a secure foundation, but it is imperative that for the solution of outstanding problems there should be precise means of registering heart sounds. This is why a phonocardiogram was included in the examination of a series of patients presenting murmurs.

As each patient attended for the test, the signs elicited on clinical auscultation were first noted and an opinion was formed on their significance. Cardioscopy was invariably carried out, and, when necessary, teleradiograms were taken. Limb and chest lead electrocardiograms were frequently recorded in addition to the lead selected as a control for the phonocardiogram. Many cases came to necropsy. The simultaneous electrocardiogram and sound record was taken by a double string galvanometer supplied by the Cambridge Instrument Company, and the length of the connecting tube leading from the chest to the amplifier was 46 cm. Although the amplitude of sounds and murmurs was matched against each other in individual patients, there was no attempt to standardize the intensity of murmurs in terms of amplitude in different patients; in fact it was varied deliberately in order to produce such excursion of the recording fibre as would best show the murmur.

The actual place of the murmur in the cardiac cycle received first attention, and its intensity was only incidentally observed and noted. Before engaging in a phonocardiographic analysis of heart murmurs it is necessary to know the place occupied by each heart sound in the cardiac cycle as timed by the simultaneous electrocardiogram. In the physiological tracing obtained with a short connecting tube of 46 cm. the auricular moiety of the first heart sound begins at the end of the P wave of the electrocardiogram; occasionally it starts a little later, but never earlier. During the R-S period the auricular sound is reinforced abruptly by the ventricular moiety of the first heart sound. This combined sound effect is completed as a rule before the start of the T wave; at the end of the T wave the second heart sound starts (Fig. 1). After a brief interval the third heart sound is usually seen, and it is often obvious though inaudible on auscultation.

To simplify the location of murmurs in relation to the separate phases of the cardiac cycle it is well to draw a line through a point that marks the end of the S wave of the electrocardiogram and prolong it to intersect the phonocardiogram: this may be named the S line. A murmur that precedes the S line is the effect of auricular systole; if it starts at the S line

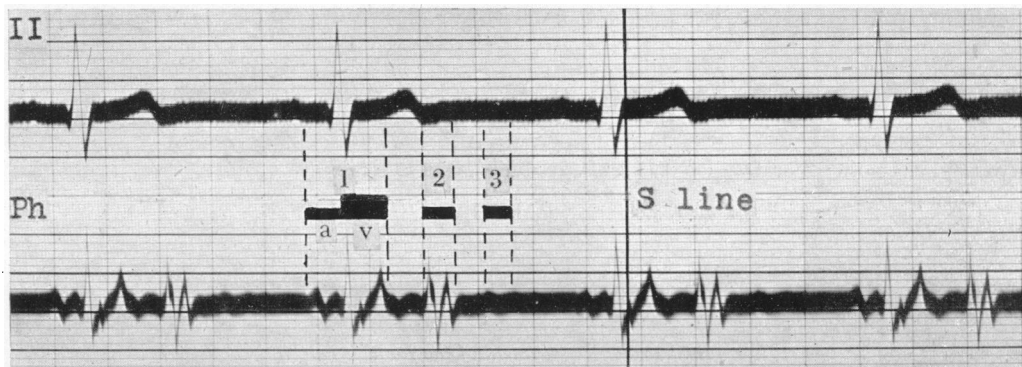


FIG. 1.—Normal phonocardiogram showing the heart sounds in relation to the electrocardiogram. The S line drawn at the end of the S wave of the electrocardiogram and continued to intersect the phonocardiogram, marks the early phase of ventricular contraction. The auricular (a) and ventricular (v) moieties of the first heart sound are shown, as well as the second (2) and third (3) heart sounds; the third was inaudible.

it coincides with the early phase of ventricular systole; if it starts a little later than the S line the murmur occupies mid-systole. Next the customary form of the graphic complex depicting the separate normal heart sounds should be studied in order that the variant produced by the addition of a murmur may be recognized. They differ one from the other only in the frequency of the vibration which creates them. Thus, the oscillations produced by a heart sound are fewer or coarser, those produced by a murmur are more numerous and finer—they bear the same relation to one another as the teeth of a coarse hair comb bears to a fine one (Fig. 2).

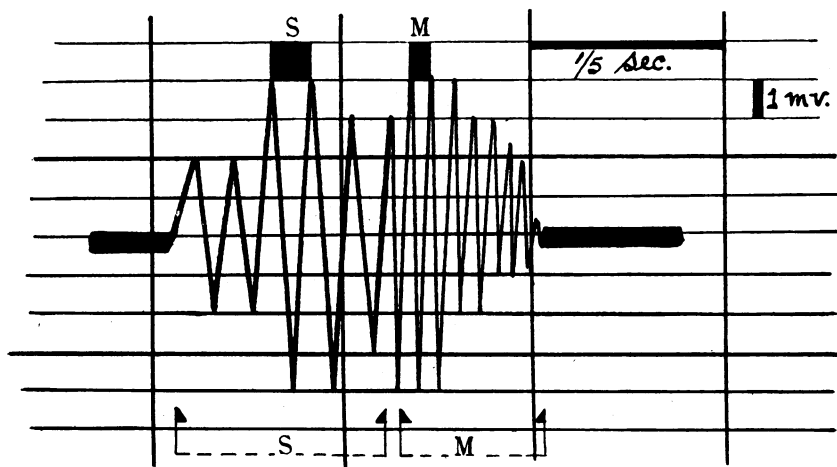


FIG. 2.—Diagrammatic representation of a heart sound (S) and murmur (M) in the phonocardiogram. The sound is a coarser vibration than the murmur, and the distance between each vibration forms a square in relation to the millimetre scale in the case of a heart sound and an oblong in the case of a murmur.

A phonocardiographic study of murmurs is fruitless unless it is closely linked with the clinical analysis of the patients concerned. The findings of this investigation, therefore, are discussed in relation to patients in seven main clinical groups, namely, healthy subjects, mitral valve disease, aortic valve disease, hypertension, congenital heart disease, heart block, and anæmia.

I. THE INNOCENT MURMURS

It has been traditional to speak of functional murmurs in the mitral area, but a search of the literature has shown a scarcity of observations on the characteristic features, apart from their quiet quality, that might identify such murmurs as the innocent kind. The need for such observations becomes obvious when clinical cardiology includes within its scope the examination of school-children whose playtime activities have been restricted and their early schooling neglected by non-attendance, recruits who have been denied military service and relegated to a low health category by medical boards, applicants for life insurance either rejected or accepted at increased premiums, and casual patients whose past health history recounts the handicap from restrictions imposed after examination of the heart—all because an insignificant murmur had been mistaken for one that indicates organic heart disease. Should this murmur be associated with “growing pains” or with a past history of rheumatic fever, the unjustified invalidism is more certain to be enforced. This uncertainty regarding individual mitral murmurs has imparted to them an ambiguity that has greatly hindered the diagnosis of cardiovascular disorders. It is clear, therefore, that identification of the *innocent* murmur, is as important, if not more important than the recognition of a murmur signifying disease and requires such specific clinical and graphic features as will make its diagnosis easier and surer.

Among patients attending the Cardiac Department of the London Hospital during four years there were 330 with an innocent mitral murmur. Care was taken to establish its benign nature, but naturally short of necropsy. A routine clinical examination followed a medical history, and special attention was paid to the site, intensity, length, and conduction of the murmur, and the effect of posture, respiration, and tachycardia upon it. Its position in the cardiac cycle, often difficult, was particularly sought, and the presence of a thrill was always tested. Diastolic murmurs were never present. An electrocardiogram was often taken whenever it might help to exclude certain organic disease, but as it never showed changes peculiar to the innocent group, it was not adopted as a routine. A selected lead was, of course, recorded to control the phonocardiogram whenever this was taken. Great reliance was placed on cardioscopy, which was used in every case and the progress of a barium swallow was watched in both oblique positions. Phonocardiography was applied frequently and as the investigation proceeded the features of the tracing could be predicted after clinical examination; such sound records were compared with those obtained from the mitral area in patients with heart disease.

Following the clinical and phonocardiographic examination it was found that although subjects with innocent murmurs could be conveniently separated into certain groups, the exact mechanism of the murmur could not be determined as neither the clinical nor the special examination provided a clue. The condition of the pericardium, mediastinum, lungs, pleura, and diaphragm was scrutinized during radiology of the chest, but this showed no obvious or consistent abnormality and failed to explain the source of the murmur. Even phonocardiography, which demonstrated the place of the murmur in relation to the cardiac cycle, did not disclose the mechanism. Necropsy in these subjects is awaited, although such an event would naturally be fortuitous; even then it is unlikely that the cause of the murmur would show. The fact that the mechanism of the innocent murmur is unexplained need not encourage conjecture on its ways of production, and must not delay the building of a clinical syndrome that might by itself decide the innocent nature of the murmur. Although the first grouping was on clinical grounds, phonocardiography later showed that these grounds were valid, hence great emphasis is given to sound records in this investigation.

THE MURMURS IN MID-SYSTOLE

This was by far the commonest variety of innocent murmur and accounted for 262 of the 330 cases. It occurred with equal frequency in both sexes. The murmur was never rough nor harsh, but it could be described as roughish or blowing in character; very occasionally it was musical. The distinctive feature was the position of the murmur in mid-systole so that in the phonocardiogram (Fig. 3 and 4) it commenced a little way beyond the *S line* and did not last long. In this respect the tracing differed from the one obtained in mitral disease, where the murmur usually preceded the *S line*, starting within the P-R period (Fig. 5). Although

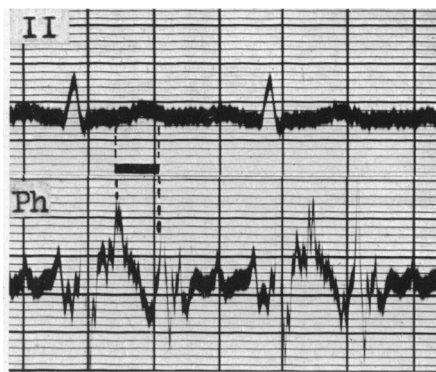


FIG. 3.—The innocent systolic murmur of reclining posture. In this and succeeding records the murmur is indicated by a black line, the start and finish of which is projected on to the electrocardiogram and phonocardiogram.

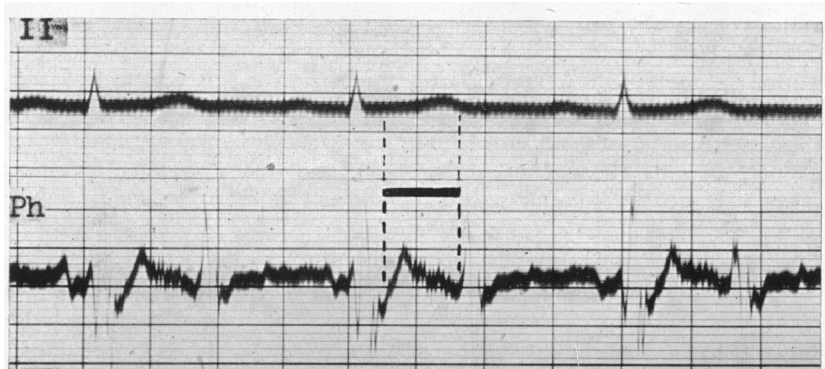


FIG. 4.—The innocent systolic murmur of upright posture.

it was not always possible, especially under the handicap of tachycardia, to establish the mid-systolic position of this murmur by auscultation, whenever a gap was detected between the first heart sound and the murmur following it, it was proof of its innocence. The corroborative test of phonocardiography, therefore, has been invaluable in establishing the validity of the clinical signs proposed for the identification of the separate varieties of innocent murmur.

Apart from its selective position in systole—slightly postponed in fact—which gives to this murmur its distinctive character, there were clinical features that decided by themselves its innocent nature even without a phonocardiogram. From a consideration of the site and intensity of the murmur, and the influence upon it of posture, it was found that the cases

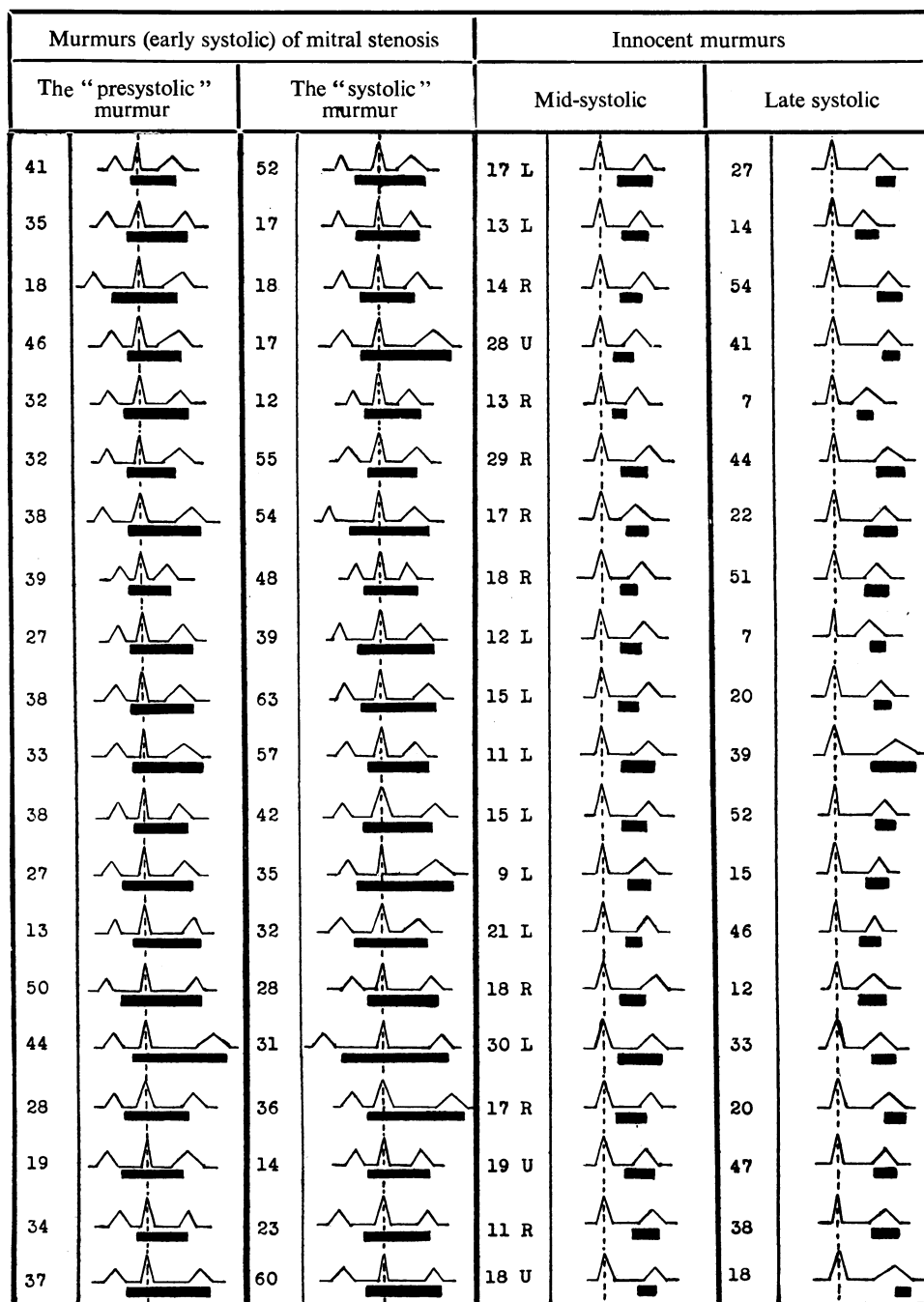


FIG. 5.—The position of mitral systolic murmurs (represented by black lines) in relation to the electrocardiogram in 40 patients with mitral stenosis (20 with a presystolic and 20 with a systolic murmur), and in 40 healthy subjects with innocent murmurs (20 with the murmur in mid-systole and 20 in late systole). Figures denote ages. Letters in the third column designate the clinical classification for innocent murmurs, thus, R is the murmur of Reclining Posture, U the murmur of Upright Posture, and L the Loud Variety.

could be allocated to four groups. The investigation has emphasized the importance of this clinical classification in the identification of this murmur, and the characteristic signs summarized in Table I, will now be described for each group. It bears repetition that the value of the phonocardiogram has so far been found not in its routine use for the detection of innocent murmurs, but to confirm the validity of the clinical signs assigned to innocent murmurs; and this it has done.

TABLE I
DISTINCTIVE CLINICAL FEATURES IN 330 HEALTHY SUBJECTS WITH AN INNOCENT MURMUR

Special features	The murmur in mid-systole (262 cases)				The murmur in late systole (68 cases)
	The murmur of reclining posture (135)	The murmur of upright posture (80)	The loud variety of murmur (7)	The parasternal murmur (40)	
Age	Young subjects	Young adults	Young subjects	Older adults	Any age
Character	Blowing or roughish	Blowing or roughish	Blowing or roughish	Blowing or roughish	Blowing or roughish
Intensity	Not loud	Not loud	Loud	Loud	Loud
Effect of deep inspiration on intensity	Disappears to auscultation	Disappears to auscultation	Persists	Persists	Persists
Effect of posture on intensity	Louder in reclining posture	Louder in upright posture	Trivial	Trivial	Trivial
Effect of posture on distribution	Murmur appears in pulmonary area on reclining	None	Towards axilla in upright, and towards base in reclining posture	None	None

THE MURMUR OF RECLINING POSTURE

Among the clinical signs common to cases in whom a subsequent special examination showed no evidence of heart disease was the fact that the murmur was louder in the reclining than the upright posture. By itself such a sign cannot be distinctive, but along with others it eased the recognition of the murmur and this justified the name given to it. This group of innocent murmur held 135 of the 330 cases. Children under 10 were not accepted; 88 cases were between the ages of 10 and 19, 36 between 20 and 29, and 11 between 30 and 39; there was none older than 40 so that the murmur is confined to younger subjects. The murmur was never loud or long and because of this it was little conducted, and with few exceptions it was dispelled by deep inspiration. It was best heard over an area just internal to the mitral area. Tachycardia was without constant effect on its intensity. The murmur was always louder in the reclining posture, and it was characteristic of this group that as the subject reclined a murmur appeared in the pulmonary area. In 12 instances the pulmonary murmur was also audible in the upright posture, and, if so, the murmur was louder in the reclining posture at the pulmonary area than at the mitral. In 15 cases the pulmonary murmur added in the reclining posture was conducted towards the aortic area, but a silent area separated the pulmonary and mitral murmurs as in the other cases.

All 135 cases were referred for special cardiological examination because a diagnosis of valvular disease had been entertained, usually by more than one medical practitioner. In 38 there was a long history of cardiac invalidism on the grounds that the murmur indicated mitral disease. Twenty-five cases had suffered some time from rheumatic fever or chorea, and for that reason the murmur had gained a greater significance, and organic heart

disease was regarded as the cause with greater confidence. Among restrictions, handicaps, and penalties, to which subjects in this group had yielded, were rest in bed for several months, prevention from taking part in games and physical exercises including swimming, allocation to a low health category by Military Recruiting Boards denying admission for military service, dismissal from certain civilian occupations, and failure to enter others.

THE MURMUR OF UPRIGHT POSTURE

This murmur was found in 80 of the total of 330 cases. Thirty-nine were between the ages of 10 and 19, 22 between 20 and 29, 16 between 30 and 39, and 3 between 40 and 43. A comparison of the age incidence of this group with the previous one shows that the murmur of reclining posture belongs to a rather earlier age than the murmur of upright posture, thus, for the former group the murmur was twice as common at ages under 20 years as over, and for the latter group it was twice as common at ages over 20 as under.

Unlike the murmur of reclining posture, this murmur was better heard in the upright posture. Although diffuse in its distribution over a small area internal to the mitral it was never conducted afar because it was never loud, and except for 13 instances it disappeared on deep inspiration.

All 80 subjects had been suspected by one or more medical practitioners of having mitral disease, and in 18 unwarranted invalidism had been enforced. As in the previous group so also in this one, such invalidism was commoner in the presence of a past history of rheumatic fever or chorea, and this applied to 13 cases.

THE LOUD VARIETY

Although only 7 examples of this murmur are cited it is likely that it is a good deal commoner than this figure suggests because the low incidence here is partly explained by the fact that its innocent nature was only recognized with certainty towards the end of this investi-

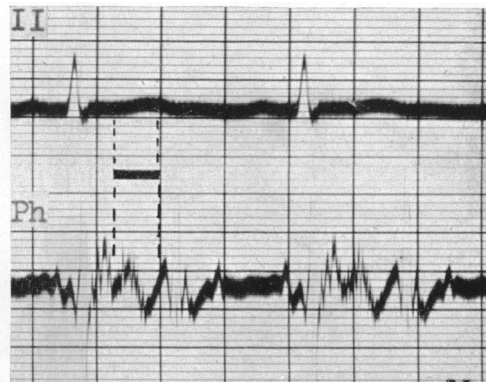


FIG. 6.—The loud variety of innocent systolic murmur.

gation; more cases have come to my notice since the present analysis was completed. Indeed the small number is not a measure of its importance for this lies in the certainty with which the murmur is mistaken for one indicating mitral disease. The ages ranged from 11 to 20 years so that this murmur, too, appears to be confined to young subjects.

The murmur was loud but never rough or harsh: like other varieties one of its peculiar features was its fineness, demonstrated by its roughish, blowing, or whiffy character. It was

lessened but never abolished by deep inspiration, and as in the case of other innocent murmurs, which were obscured or diminished by deep inspiration, it was noticed that when respiration was resumed the murmur regained its customary intensity only after two or three heart beats. It was diffuse in its distribution and in the cases examined it spread towards the axilla in the upright posture when it was loudest, and towards the sternal border and pulmonary area in the reclining posture.

On careful auscultation it was possible, unless hindered by tachycardia, to identify its position in mid-systole and the small gap between the first heart sound and the murmur, but a phonocardiogram was desirable to support the clinical diagnosis in this instance, for because of its intensity the murmur suggested the diagnosis of mitral disease; the phonocardiogram (Fig. 5 and 6) gave proof of its innocence by placing the murmur in mid-systole and by showing the absence of murmurs characteristic of mitral stenosis.

THE PARASTERNAL MURMUR

This murmur was present in 40 of the 330 cases. Twelve were between the ages of 10 and 19, 9 between 20 and 29, 13 between 30 and 39, and there were 6 over 40.

Because the murmur was loud it was never abolished by deep inspiration. It was audible for a little distance away from its point of maximum intensity in the fourth intercostal space at the left border of the sternum. Posture had no great influence on its intensity. Although loud it was never harsh, and it was usually described as roughish, blowing, or whiffy, terms that emphasize the fineness of the vibration. The murmur was never associated with a thrill, which helped to distinguish it from the murmur of ventricular septal defect heard in the same position. Sometimes it was possible to make out on clinical auscultation that the murmur occupied mid-systole because of the short gap which separates the first heart sound from the murmur that follows it. This was told with certainty by the phonocardiogram (Fig. 7 and 9) which demonstrated the murmur starting a little distance beyond the S line and later than the murmur of ventricular septal defect which starts at the S line (Fig. 8 and 9).

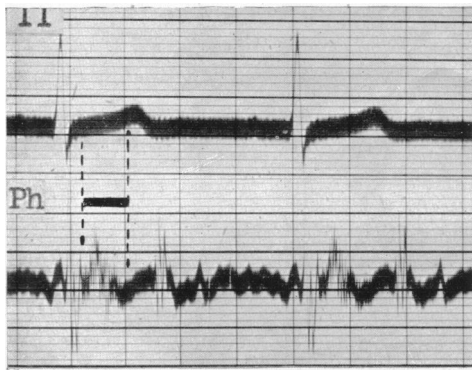


FIG. 7.—The innocent parasternal murmur.

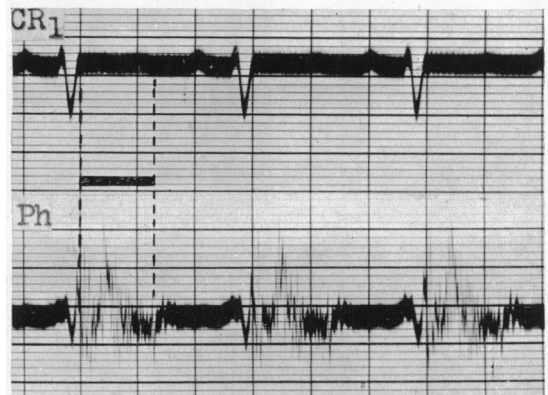


FIG. 8.—The murmur of ventricular septal defect.

The electrocardiogram was useful in this group of cases because it was always normal, whereas it was often abnormal in the cases of ventricular septal defect studied alongside the innocent group. In the same way cardioscopy was indispensable for there was never enlargement of the heart in the cases showing the innocent parasternal murmur, while in the patients with the congenital lesion there was often some degree of right heart enlargement.

Owing to the peculiar site of the murmur most of these cases had been regarded as instances of congenital heart disease, but some had been diagnosed as mitral disease, especially those with a past history of rheumatic fever, 10 in number.



















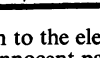
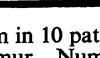
Ventricular septum defect		Innocent parasternal murmur.	
29		36	
16		37	
10		19	
11		21	
17		36	
17		41	
11		21	
6		38	
45		12	
21		23	

FIG. 9.—Position of murmurs in relation to the electrocardiogram in 10 patients with ventricular septal defect, and in 10 subjects with innocent parasternal murmur. Numerals denote ages.

THE MURMUR IN LATE SYSTOLE

In this important group there were 68 cases. Seventeen were between the ages of 10 and 19, 12 between 20 and 29, 15 between 30 and 39, 13 between 40 and 49, and 6 between 50 and 59; there were 5 over 60 years of age.

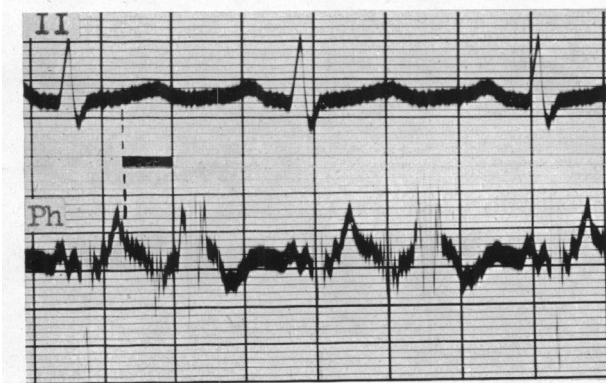


FIG. 10.—The innocent murmur in late systole.

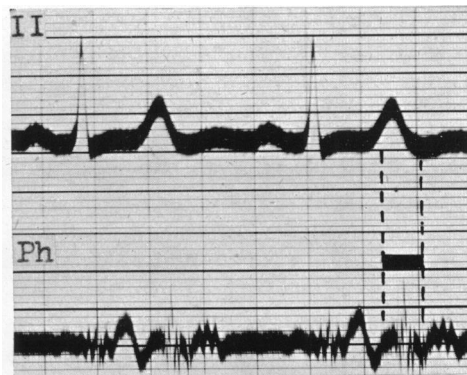


FIG. 11.—The innocent murmur in late systole.

The murmur was loud and for this reason it was heard some distance away from its site of maximum intensity in the mitral area, and it was still audible on deep inspiration. Posture had no specific effect on the murmur although in many it was a little louder in the upright posture. The quality of the murmur was never rough or harsh, and in common with other innocent murmurs it was described as roughish or blowing. Its most distinctive feature was its lateness in systole for it was placed nearer to the second than the first heart sound showing an obvious gap between the first sound and the murmur. The phonocardiogram (Fig. 5, 10, and 11) always confirmed its position towards the end of systole; it started near the commencement of the T wave and seldom lasted till the end of systole and the second heart sound. In other cases, not included here, a clear *sound* appeared in late systole initiating an innocent kind of triple heart rhythm.

As the murmur was so loud and as it occurred in subjects of all ages, it proved even a greater source of unwarranted invalidism, for once consigned to this inferior health category it lasted for a lifetime because the murmur lasted as long.

SUMMARY: INNOCENT MURMURS

The common incidence of innocent murmurs and the unwarranted cardiac invalidism resulting from it give to the problem of distinguishing them from murmurs arising from heart disease a priority unequalled by any other in clinical cardiology. There is urgent need to set a clinical and cardiographic pattern for this murmur, which will make it easy to recognize. The fact that there is as yet no clue to the mechanism of its production need not promote theoretical speculation as to its cause for that might hinder rather than help in its diagnosis. From a study of 330 healthy subjects presenting a murmur, it became possible on clinical grounds alone to recognize its innocent character by placing the cases in five groups (see Table I) which have been named according to the main clinical feature. Thus, the murmur of *reclining posture* was roughish or blowing in character and was confined to young subjects; it was uncommon after 30 and absent after 40 years of age. The murmur was not loud and for that reason it was often removed by deep inspiration. It was loudest in the reclining posture, and with this posture a murmur developed in the pulmonary area. Sometimes this last murmur was audible in the upright posture too, and in this circumstance in the reclining posture it was louder in the pulmonary than mitral area. The murmur of *upright posture* was also confined to younger subjects and the oldest case was 43. It was roughish or blowing in character and was best heard in the upright posture. A *loud* variety of innocent murmur was less common, but its loudness invariably caused it to be mistaken for the systolic murmur of mitral disease: hence its importance. It occurred in young subjects. Change of posture affected the distribution of the murmur more than its intensity, so that in the upright posture it became louder towards the axilla, and in the reclining posture upwards and towards the sternum. The *parasternal* murmur was loud and was best heard in the fourth intercostal space near the left border of the sternum, but it was never accompanied by a thrill as the murmur belonging to ventricular septal defect usually is. The murmur in *late systole* was loud and was roughish in character. It occurred at all ages. It could be told easily by clinical auscultation for the murmur was placed nearer to the second than the first heart sound.

The phonocardiogram confirmed the validity of this clinical classification. In the first four varieties the murmur was recorded in mid-systole, and in the last variety in late systole. In none did the tracing show a diastolic murmur.

II. THE MURMURS OF MITRAL VALVE DISEASE

The diagnosis of long standing mitral stenosis presents no difficulty as a rule for it produces obvious physical signs. When the lesion is early its recognition may prove difficult,

while the addition of hypertension and/or of auricular fibrillation, especially when the heart is rapid, may confound the diagnosis. Great help in giving to certain auscultatory signs their true significance has come from radiology; even the presence of unusual physical signs may not prevent diagnosis of the valvular lesion after taking stock of the size and shape of the heart at cardioscopy. None the less, since the left auricle impresses the œsophagus in health, the slight departure from the normal found in early distension of the left auricle in mitral disease, often leaves a difficulty in the radiological interpretation. Two other circumstances obstruct the radiological diagnosis of mitral stenosis; first, in rare instances of undoubted mitral stenosis the heart at cardioscopy is unaltered in shape and size; secondly, when the left ventricle is enlarged from hypertension or aortic valvular disease, it deepens the left auricle impression in the right oblique view in much the same way as does the distended left auricle of mitral stenosis, although help in the differentiation can come from examination in the left oblique view. These difficulties compel a critical re-examination of the auscultatory signs of mitral disease and an inquiry into the graphic registration of those murmurs made familiar by auscultation. The three murmurs associated with mitral disease will now be considered separately.

THE PRESYSTOLIC MURMUR

A phonocardiogram was recorded in 33 patients with mitral stenosis who showed the characteristic presystolic murmur on auscultation. The association of a murmur and a loud first sound had produced a rough note which might be represented as *thurr-rupp*; this was

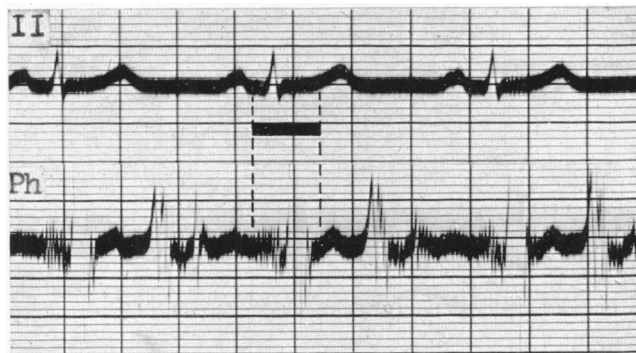


FIG. 12.—Auricular murmur in mitral stenosis where auscultation showed a presystolic murmur.

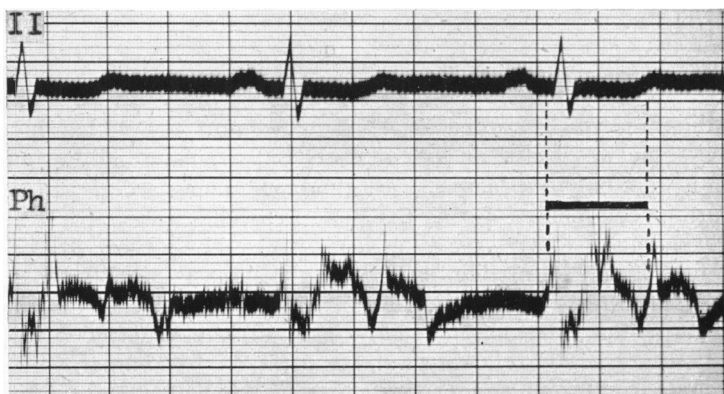


FIG. 13.—Auricular murmur in mitral stenosis where auscultation showed a presystolic murmur.

louder and more abrupt than splitting of the first heart sound found in healthy subjects, which might be represented as *r-rupp*. Although a crescendo character is customarily described for the presystolic murmur, such an effect is an auditory impression gained during auscultation for graphically the murmur does not show such progressive intensification.

In 31 cases the murmur started during the P-R period of the electrocardiogram (Fig. 5); it started at the end of the P wave in 14 (Fig. 12), early in the P-R period in 8, and late in 9 (Fig. 13). In the light of this graphic representation the term presystolic may be used as by this is meant pre-ventricular-systole, but since the murmur takes place during systole of the auricle, the term *auricular systolic murmur* is more informative, and is the name that best conforms to its scientific interpretation. In only 2 cases did the murmur, which clinically was indistinguishable from the one heard in the other 31 patients, fail to show earlier than the S line, this marking the early phase of ventricular contraction. In both it was noticed that the P wave showed a small voltage, its amplitude being less than one millimetre.

In 19 cases a mid-diastolic murmur was continued into the period of auricular systole and joined with the auricular murmur, while in the remaining 14 patients the diastolic murmur had almost spent itself before the auricular systolic murmur started.

Occasionally the friction sound in acute pericarditis (Fig. 14) can simulate the auricular

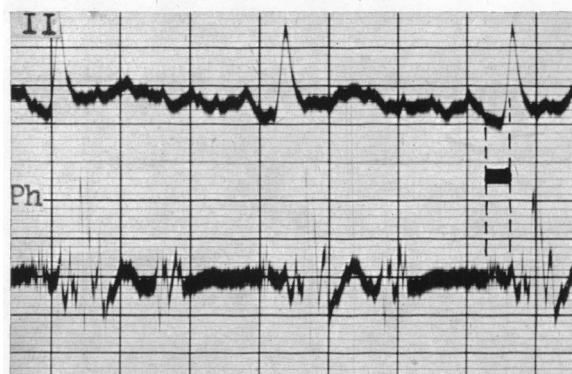


FIG. 14.—Friction sound during auricular systole in acute pericarditis.

murmur of mitral stenosis, but is easily distinguished on clinical grounds—its disappearance in a few days, the absence of a mid-diastolic murmur, and the history of the illness.

THE SYSTOLIC MURMUR

A phonocardiogram was recorded in 41 patients with undoubted mitral stenosis in whom a mitral systolic was heard on auscultation, but a presystolic murmur could not be elicited although it was sought in each case after inducing tachycardia.

In 33 the murmur commenced during the P-R period of the electrocardiogram (Fig. 5); in 8 it started at the end of the P wave (Fig. 15); in 11 early in the P-R period; in 14, late (Fig. 16). Such findings are surprising for they are the same as those in the series of patients with mitral stenosis showing a presystolic murmur. There were 8 cases in which the murmur commenced at the S line marking the early part of ventricular contraction (Fig. 17); in each of these cases a mid-diastolic murmur was present. In common with the two similar cases in the presystolic murmur series, they showed a small voltage of the P wave in the electrocardiogram with an amplitude less than one millimetre.

In 13 cases a mid-diastolic murmur was continued into the period of auricular systole and joined with the auricular murmur, while in the remaining 28 patients the diastolic murmur had almost spent itself before the start of auricular systole.

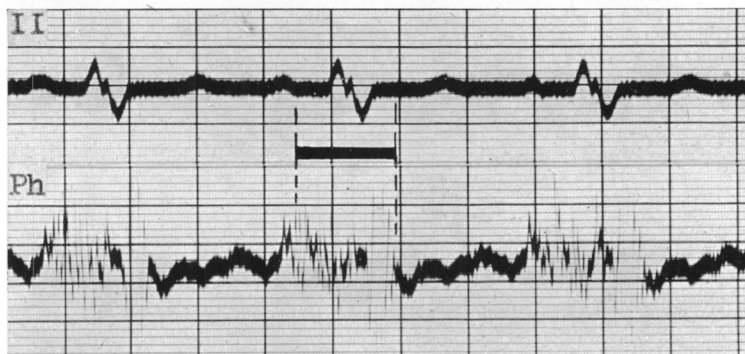


FIG. 15.—Auricular murmur in mitral stenosis where auscultation showed a systolic murmur.



FIG. 16.—Auricular murmur in mitral stenosis where auscultation showed a systolic murmur.

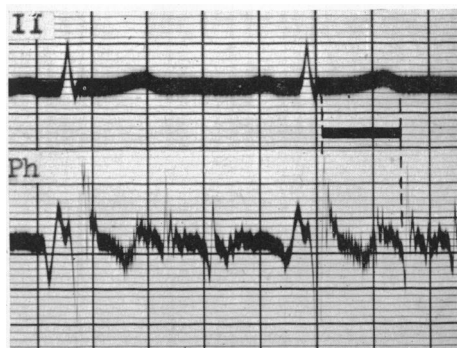


FIG. 17.—A murmur in mitral stenosis where auscultation showed a systolic murmur, which commences at the S line. Confirmation of mitral stenosis is found in the mid-diastolic murmur following the third heart sound.

THE MID-DIASTOLIC MURMUR

A further significant finding in this investigation has been the invariable presence in the phonocardiogram of a mid-diastolic murmur: it was present in every one of the 74 cases, 33 of which had a presystolic murmur and 41 a systolic murmur on auscultation. The murmur was attached to the end of the third heart sound, and in 32 cases it was continued into the period of auricular systole and was joined to the auricular systolic murmur (Fig. 18), while in the remaining 42 patients the diastolic murmur had almost disappeared when the auricular murmur started.

On clinical auscultation the mid-diastolic murmur was not elicited in 11 patients, and in 12 others the added sound was thought to be the third heart sound devoid of a murmur. The murmur was heard in the remaining 51 patients, but in 21 of these it was necessary to

listen towards the axilla with the patient inclined on the left side after induced tachycardia. In many cases with a rapid heart rate, however, the mid-diastolic murmur found on auscultation appeared to be contiguous with the auricular systolic murmur following closely on it.

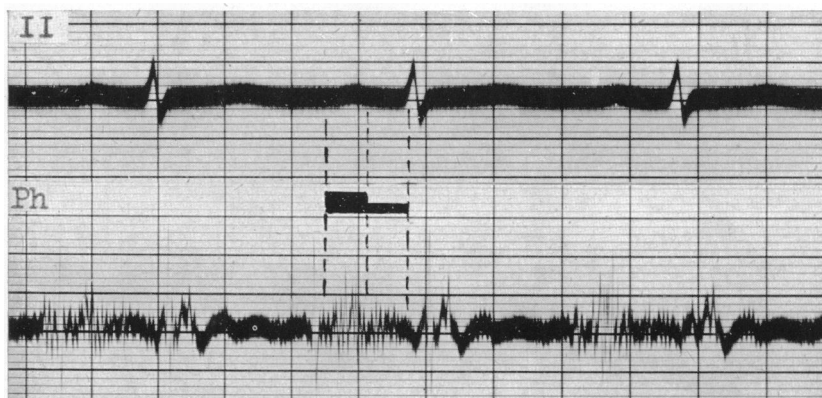


FIG. 18 —The mid-diastolic murmur of mitral stenosis, which is contiguous with the auricular murmur.

AURICULAR FIBRILLATION IN MITRAL DISEASE

Naturally, in auricular fibrillation the auricular systolic murmur was absent although often the mid-diastolic murmur approaching the ventricular part of the first heart sound provided a clinical impression of a presystolic murmur.

A phonocardiogram was taken in 20 patients with mitral stenosis and auricular fibrillation; in each the systolic murmur started at the S line, i.e. at the onset of ventricular contraction (Fig. 19). This was unlike auricular fibrillation in other conditions showing a systolic murmur such as hypertension where the murmur started later and in mid-systole (Fig. 20). Phono-

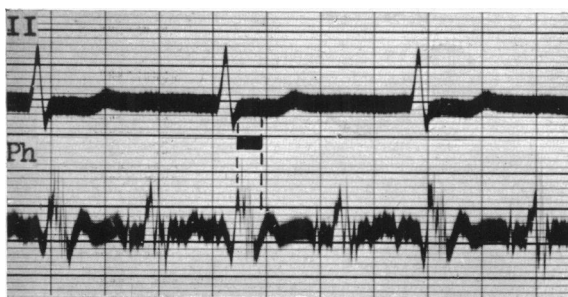


FIG. 19.—The systolic murmur in mitral stenosis with auricular fibrillation, which starts at the S line.

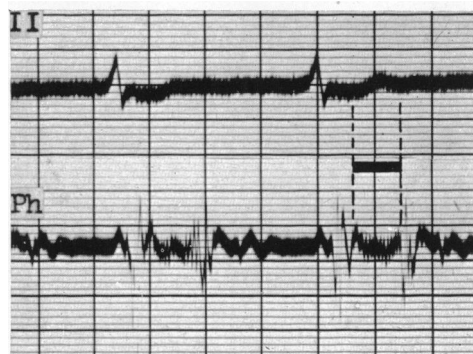


FIG. 20.—The systolic murmur in hypertension with auricular fibrillation, which starts in mid-systole and some way after the S line.

cardiographically, therefore, the diagnosis of mitral disease as the cause of fibrillation is assisted by a regard of the place of the systolic murmur; confirmation comes from finding a mid-diastolic murmur in every case. During a long diastolic phase this murmur was isolated in mid-diastole, but with a shorter diastolic period the murmur was continued up to the ventricular part of the first heart sound of the next beat.

SUMMARY: MURMURS OF MITRAL DISEASE

With two exceptions in 33 patients with mitral stenosis who had a presystolic murmur, the phonocardiogram showed the murmur starting within the P-R period, that is, during auricular systole; in the two exceptions where the murmur started at the S line marking the early phase of ventricular contraction, it was noticed that the P wave of the electrocardiogram was less than one millimetre in amplitude.

The most significant finding in this investigation is that in patients with mitral stenosis where a systolic murmur was heard on auscultation and a presystolic murmur was not elicited even after inducing tachycardia, the murmur also started during the P-R period in the majority (33 out of 41). Thus, the systolic murmur of mitral disease, like the presystolic murmur, was produced by auricular systole in such cases. The conditions in the 8 exceptions tallied with those found in the two similar examples in the presystolic murmur series, in that the murmur started at the S line, and was associated with a small P wave (of less than one millimetre in amplitude).

These graphic findings endorse the specific role of auricular contraction in producing the systolic as well as the presystolic murmur and support the view that a diagnosis of mitral stenosis should be applied to mitral valve disease whichever of the two murmurs it presents on clinical auscultation. Even in the 10 cases (2 with presystolic and 8 with systolic murmur on auscultation) where the murmur in the phonocardiogram was seen no earlier than the S line the application of the term "mitral incompetence or regurgitation" would be inaccurate because in each of them there was a mid-diastolic murmur to give proof of mitral stenosis. Indeed a mid-diastolic murmur was present in the phonocardiogram in each of the 74 cases of mitral disease, whether with a presystolic or systolic murmur, emphasizing on the one hand its value in a case with equivocal clinical and radiological signs, and on the other hand the need of searching diligently for this murmur under the most favourable circumstances, namely to listen attentively after inducing tachycardia and inclining the recumbent patient to the left side. A detailed analysis of the phonocardiograms from the two series of patients failed to explain what determined in mitral stenosis whether the murmur should be of the presystolic or systolic kind. It neither depended on the length of the P-R period nor on the duration of the diastolic phase, nor was the graphic registration of the murmur distinctive for each group. It can only be surmised that the intensity and abruptness of the first heart sound decides the presence or absence of the rough quality that typifies the presystolic murmur.